Claims

1. An ion source for use with an ion implant device, the ion source comprising:

an ionization chamber defined by a plurality of side walls defining an ionization volume, one of said sidewalls including an ion extraction aperture for enabling an ion beam to be extracted from said ionization chamber along a predetermined axis defining an ion beam axis;

an electron beam source and an aligned beam receptor configured relative to said ionization chamber to cause an electron beam to be directed across the ionization volume of said ionization chamber in a direction generally perpendicular to said ion beam axis for ionizing gas in the ionization chamber by direct electron impact ionization by energetic electrons; and

a gas source in fluid communication with said ionization chamber.

2. The ion source as recited in claim 1, wherein said electron beam source and said beam receptor are thermally isolated from said ionization chamber.

3. The ion source as recited in claim 2, wherein said ionization chamber is provided with electron entrance and electron exit ports, aligned to enable said electron beam to pass through the ionization volume of said ionization chamber in a direction generally perpendicular to said ion beam axis.

4. The ion source as recited in claim 3, wherein at least one of said electron beam source and said beam receptor are mounted to a mounting frame.

5. The ion source as recited in claim 4, wherein said mounting frame is water cooled.

6. The ion source as recited in claim 1, wherein said gas source is a removable vaporizer.

7. The ion source as recited in claim 6, wherein said ion source is configured to enable ionization of decaborane $B_{10}H_{14}$ and includes a vaporizer.

8. The ion source as recited in claim 7, wherein said ionization chamber is in thermal conduction contact with said vaporizer.

9. The ion source as recited in claim 8, further including one or more thermally conductive gaskets, disposed between said vaporizer and said ionization chamber.

10. The ion source as recited in claim 6, wherein said vaporizer is connected to said ionization chamber by way of one or more isolation valves.

11. The ion source as recited in claim 1, wherein said electron beam source includes an electron gun having a cathode.

12. The ion source as recited in claim 10, wherein said beam receptor is maintained at a positive potential relative to said cathode.

13. The ion source as recited in claim 3, wherein said beam receptor is spaced away from said electron exit aperture.

14. The ion source as recited in claim 3, wherein said beam receptor is configured to be at least partially disposed within said electron exit aperture 36 but thermally and electrically isolated from said ionization chamber.

15. The ion source as recited in claim 14, wherein said thermal and electrical isolation is provided by a mechanical gap.

16. The ion source as recited in claim 14, wherein said thermal and electrical isolation is provided by electrical insulation (Z).

17. The ion source recited in claim 1, further including an outer housing (Hc) formed with one or more cooling chambers relative to said ionization chamber, said outer housing (Hc) provided with one or more fluid inlets (Gi) for receiving a predetermined cooling fluid.

18. The ion source as recited in claim 17, wherein said cooling fluid is a conductive gas.

19. The ion source as recited in claim 18, wherein said conductive gas is selected from the group N_2, Ar and He.

20. The ion source as recited in claim 1, wherein said ionization chamber is water cooled.

21. The ion source as recited in claim 1, wherein one of said sidewalls of said ionization chamber defines an ion exit aperture plate formed with an ion beam exit aperture, the size of the ion beam exit aperture selected as a function of the size of the electron beam within the ionization chamber.

22. The ion source as recited in claim 1, wherein said electron source includes a cathode having a generally planar emitting surface which generates electrons in a direction generally perpendicular to the planar emitting surface in response to heat.

23. The ion source as recited in claim 22, wherein said cathode is heated directly by passing an electric current through it.

24. The ion source as recited in claim 22, wherein said cathode is heated indirectly by passing an electric current through a filament disposed adjacent to said cathode causing the filament to emit thermionic electrons which heat the cathode by energetic electron bombardment.

25. The ion source as recited in claim 1, wherein the ion source is formed with a retrofit volume and configured to enable said ion source to be installed in existing ion implanter devices (FIG. 8A) in which the ion source has been removed.

26. The ion source as recited in claim 1, wherein said electron beam source comprises:

an extended housing;

one or more mounting flanges for mounting said electron beam source to said ion source;

a cathode for emitting electrons;

one or more feedthroughs extending through said extended housing for connection to one or more electrical conductors and to said cathode;

an optics system for directing the electron beam into said ionization chamber; and

an extraction stage.

27. The ion source as recited in claim 26, wherein said optics system is configured to cause said electron beam to be directed along an axis generally perpendicular to a longitudinal axis of said extended housing.

28. The ion source as recited in claim 26, wherein said optics system includes a collimation lens.

29. The ion source as recited in claim 26, wherein said optics system includes a mirror.

30. The ion source as recited in claim 26, wherein said optics system includes a zoom lens.

31. The ion source as recited in claim 26, wherein said feedthroughs include a water inlet and a water outlet for cooling said housing.

32. The ion source as recited in claim 26, wherein said cathode is formed as a planar cathode emitter plate..

33. The ion source as recited in claim 32, wherein said cathode is adapted to be resistance heated.

34. The ion source as recited in claim 32, wherein said cathode is adapted to be indirectly heated.

35. The ion source as recited in claim 1, wherein said ionization chamber is configured to be removably mounted as an end module from a mounting block which forms part of the ion source.

36. The ion source as recited in claim 35, further including a conductive seal (6"), disposed between said end module and said mounting block.

37. The ion source as recited in claim 35, wherein the material for said end module is selected from the group of aluminum and molybdenum.

38. The ion source as recited in claim 35, wherein the material for said end module is selected from the group of graphite and SiC.

39. The ion source as recited in claim 35, wherein the interface between block and end module is filled with gas to provide thermal conduction between the two.

40. The ion source as recited in claim 35, wherein said mounting block includes a plurality of water passages.

41. The ion source as recited in claim 26, wherein said extraction stage is formed in a cylindrical shape.

42. The ion source as recited in claim 26, wherein said extraction stage includes a field shaping grid electrode, a Wehneldt electrode, a lens and an anode.

43. The ion source as recited in claim 42, wherein said grid electrode is maintained at a grid potential Vg at $-2V < Vg < +4V$ and the potential of said anode is in the range of 200V-1000V.

44. The ion source as recited in claim 28, wherein said collimation lens is an asymmetric einzel lens.

45. The ion source as recited in claim 30, wherein said zoon lens is formed as a compound element lens.

46. The ion source as recited in claim 45, wherein said zoom lens is formed as a five element lens.

47. The ion source as recited in claim 45, wherein said zoom lens is formed from two three-element lenses (AEL1, ALE2) in tandem.

48. The ion source as recited in claim 45, wherein said zoom lens is formed from two asymmetric einzel lenses in tandem.

49. The ion source as recited in claim 29, wherein said mirror is configured to displace the beam axis by about 90°.

50. The ion source as recited in claim 49, wherein said mirror is formed by two plates, oriented about 45° from the axis of the zoom lens.

51. The ion source as recited in claim 26, wherein said ion source is configured to provide an electron beam with an acceleration-deceleration mode of operation.

52. The ion source as recited in claim 51, wherein said ion source includes a zoom lens.

53. The ion source as recited in claim 26, wherein said optical system includes a mirror and said ion source includes a deceleration stage, disposed between said mirror and said ionization chamber.

54. The ion source as recited in claim 1, wherein said electron beam source comprises:

a cathode for emitting electrons defining an electron beam axis, said cathode configured such that said electron beam axis is aligned with said electron entrance and exit ports on said ionization chamber;

an extraction stage for extracting electrons from said cathode; and

a double aperture lens.

55. The ion source as recited in claim 54, wherein said electron beam source is configured to replace existing ion sources in existing ion implant devices.

56. The ion source as recited in claim 1, further including a control system for controlling said ion source.

57. The ion source as recited in claim 1, wherein said electron beam source is followed by a deceleration stage which reduces the energy of the electron beam prior to penetrating the ionization volume of said ionization chamber.

58. The ion source as recited in claim 1, wherein said electron beam source has an emitter external to the ionization volume said ionization chamber

59. The ion source as recited in claim 1, wherein one wall of said ionization chamber is formed by an ion extraction aperture plate in thermal contact with said ionization chamber by way of conductive gasket.

60. The ion source as recited in claim 1, wherein said gas source includes a vaporizer and a conduit between said vaporizer and said ionization chamber.

61. The ion source as recited in claim 1, wherein the conduit between the vaporizer and the ionization chamber has a high gas conductance of the order of between about 3×10^{-2} to 3×10^{-1} liters per second.

62. The ion source as recited in claim 1, wherein said gas source is a plurality of vaporizers (VAP1, VAP2).

63. The ion source as recited in claim 1, wherein the gas source crucible in which the solid source material resides is at a temperature achieved by temperature control of vaporizer housing.

64. The ion source (1) as recited in claim 63, wherein a space is defined between the crucible (18, 18′) and the temperature-controlled vaporizer housing (17, 29′) is filled with gas to provide thermal conduction therebetween.

65. The ion source as recited in claim 1, wherein the system is configured so that the electrons enter the ionization chamber as a generally collimated beam.